



Designation: A 209/A 209M – 9803

Standard Specification for Seamless Carbon-Molybdenum Alloy-Steel Boiler and Superheater Tubes¹

This standard is issued under the fixed designation A 209/A 209M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

¹ This specification is under the jurisdiction of ASTM Committee A-1 A01 on Steel, Stainless Steel, and Related Alloys, and is the direct responsibility of Subcommittee A01.10 on Tubing.

Current edition approved Dec. 10, 1998; 2003. Published February 1999; October 2003. Originally published as A 209 – 38 T, approved in 1938. Last previous edition approved in 1998 as A 209/A 209M – 958.

1. Scope*

1.1 This specification² covers several grades of minimum-wall-thickness, seamless, carbon-molybdenum alloy-steel, boiler and superheater tubes.

1.2 This specification covers tubes ½ to 5 in. [12.7 to 127 mm] inclusive, in outside diameter and 0.035 to 0.500 in. [0.9 to 12.7 mm], inclusive, in minimum wall thickness.

1.3 An optional supplementary requirement is provided and, when desired, shall be so stated in the order.

1.4 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the specification. The inch-pound units shall apply unless the “M” designation of this specification is specified in the order.

2. Referenced Documents

2.1 *ASTM Standards*:^{3 4}

A 451016/A45 1016M Specification for General Requirements for ~~Carbon, Ferritic-Alloy, and Alloy Steel~~, Austenitic Alloy Steel Tubes⁴

² For ASME Boiler and Pressure Vessel Code application see related Specification SA-209 in Section II of that Code.

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

⁴ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards*; Vol 01.01, volume information, refer to the standard's Document Summary page on the ASTM website.



A 941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys⁴ Stainless Steel Tubes

3. Terminology

3.1 ~~Definitions~~—For definitions of terms used in this specification, refer to Terminology A 941.

4. Ordering Information

4.1 Orders for material under this specification shall include the following, as required, to describe the desired material adequately:

- 4.1.1 Quantity (feet, metres, or number of lengths);
- 4.1.2 Name of material (seamless tubes);
- 4.1.3 Grade (Table 1);
- 4.1.4 Manufacture (hot-finish or cold-finished);
- 4.1.5 Size (outside diameter and minimum wall thickness);
- 4.1.6 Length (specific or random);
- 4.1.7 Test reported required (see Certification Section of Specification A 450/A 450M);
- 4.1.8 Specification designation, and
- 4.1.9 Special requirements and any supplementary requirements selected.

5. General Requirements

5.1 Material

3.1 Product furnished under this specification ~~should~~ shall conform to the ~~applicable~~ requirements of Specification A 1016/A 1016M, including any supplementary requirements that are indicated in the ~~current edition~~ purchase order. Failure to comply with the general requirements of Specification A ~~451016/A 451016M~~; constitutes ~~nonconformance with this specification~~. In case of conflict with the rwise pquirements ovf thids specification and Specification A 1016/A 1016M, this specification shall prevail.

6. Materials and Manufacture

64.1 ~~—Steelmaking Practice~~—The steel shall be killed.

64.2 The tubes shall be made by the seamless process and shall be either hot-finished or cold-finished, as specified. 7

4.3 ~~Heat Treatment~~7.1—Hot-finished tubes shall be heat treated at a temperature of 1200 °F [650 °C] or higher. Cold-finished tubes shall, after the final cold finishing, be heat treated at a temperature of 1200 °F [650 °C] or higher, or tubing may be furnished in the full-annealed, isothermal annealed, or normalized and tempered condition. If furnished in the normalized and tempered condition, the minimum tempering temperature shall be 1200 °F [650 °C].

8. Chemical Composition

85.1 The steel shall conform to the requirements ~~as to chemical composition prescribed given~~ in Table 1.

9. Product Analysis

9.1 An analysis shall be made by the manufacturer of one billet or one tube from each heat. The chemical composition thus determined, shall conform to the requirements specified.

9.2 If the original test for product analysis fails, retests of two additional billets or tubes shall be made. Both retests for the elements in question shall meet the requirements of the specification; otherwise all remaining material in the heat or lot (Note 1) shall be rejected or, at the option of the producer, each billet or tube may be individually tested for acceptance. Billets or tubes which do not meet the requirements of the specification shall be rejected.

NOTE 1—For flattening and flaring requirements, the term *lot* applies to all tubes prior to cutting of the same nominal size and wall thickness which are produced from the same heat of steel. When final heat treatment is in a batch-type furnace, a lot shall include only those tubes of the same size and from the same heat which are heat treated in the same furnace charge. When the final heat treatment is in a continuous furnace, the number of tubes of the same size and from the same heat in a lot shall be determined from the size of the tubes as prescribed in Table 2 1. NOTE 2—For tension and hardness test requirements;

TABLE 1 Chemical Requirements

| Element | Composition, % | | |
|-----------------|----------------|-----------|-----------|
| | Grade T1 | Grade T1a | Grade T1b |
| Carbon | 0.10–0.20 | 0.15–0.25 | 0.14 max |
| Manganese | 0.30–0.80 | 0.30–0.80 | 0.30–0.80 |
| Manganese | 0.30–0.80 | 0.30–0.80 | 0.30–0.80 |
| Phosphorus, max | 0.025 | 0.025 | 0.025 |
| Sulfur, max | 0.025 | 0.025 | 0.025 |
| Silicon | 0.10–0.50 | 0.10–0.50 | 0.10–0.50 |
| Molybdenum | 0.44–0.65 | 0.44–0.65 | 0.44–0.65 |



TABLE 25 Number of Tubes in a Lot Heat Treated by the Continuous Process

| Size of Tube | Size of Lot |
|--|-------------------------|
| 2 in. [50.8 mm] and over in outside diameter and 0.200 in. [5.1 mm] and over in wall thickness | not more than 50 tubes |
| 2 in. [50.8 mm] and over in outside diameter and under 0.200 in. [5.1 mm] in wall thickness | not more than 75 tubes |
| Less than 2 in. [50.8 mm] but over 1 in. [25.4 mm] in outside diameter | not more than 75 tubes |
| 1 in. [25.4 mm] or less in outside diameter | not more than 125 tubes |

5.2 Product Analysis

5.2.1 An analysis shall be made by the term *lot* applies to all tubes prior to cutting, manufacturer of the same nominal diameter and wall thickness which are produced one billet or one tube from each heat. The chemical composition thus determined, shall conform to the requirements given in Table 1.

5.2.2 If the original test for product analysis fails, retests of steel. When final heat treatment is two additional billets or tubes shall be made. Both retests for the elements in a batch-type furnace, a lot question shall include only those tubes meet the requirements of the same size and the same heat which are heat treated specification; otherwise all remaining material in the same furnace charge. When the final heat treatment is in a continuous furnace, a or lot (See 7.1) shall include all tubes be rejected or, at the option of the same size and heat, heat treated in producer, each billet or tube may be individually tested for acceptance. Billets or tubes that do not meet the same furnace at requirements of the same temperature, time at heat, and furnace speed.

10. Tensile Requirements

10.1 The specification shall be rejected.



6. Mechanical Properties

6.1 Tensile Requirements

6.1.1 The material shall conform to the requirements ~~as to tensile properties prescribed given~~ in Table 3 2.

6.10.2 Table 4 3 gives the computed minimum elongation values for each $\frac{1}{32}$ -in. [0.8-mm] decrease in wall thickness. Where the wall thickness lies between two values shown above, the minimum elongation value shall be determined by the following equation:

$$E = 48t + 15.00 \quad [E = 1.87t + 15.00] \quad (1)$$

where:

E = elongation in 2-in. [50 mm], %, and,

t = actual thickness of specimen, in. [mm].

11. Hardness Requirements

11.1 The

6.2 *Hardness Requirements*—The tubes shall have a hardness not exceeding the values given in Table 5 4.

12. Mechanical

6.3 *Number of Tests Required*

12.1—

6.3.1 *Tension Test*—One tension test shall be made on a specimen for lots of not more than 50 tubes. Tension tests shall be made on specimens from two tubes for lots of more than 50 tubes ~~(Note 2)~~.

12.2—(See 7.2)

6.3.2 *Flattening Test*—One flattening test shall be made on specimens from each end of one finished tube, not the one used for the flaring test, from each lot ~~(Note 1)~~.

12.3—(See 7.1)

6.3.3 *Flaring Test*—One flaring test shall be made on specimens from each end of one finished tube, not the one used for the flattening test, from each lot ~~(Note 1)~~.

12.4—(See 7.1)

6.3.4 *Hardness Test*—Brinell or Rockwell hardness tests shall be made on specimens from two tubes from each lot ~~(Note 2)~~.

12.5 *Hydrostatic Test*—Each tube (See 7.2)

7. Sampling

7.1 *Flattening, Flaring, and Product Analysis*—For flattening, flaring, and product analysis requirements, the term *lot* applies to all tubes prior to cutting of the same nominal size and wall thickness that are produced from the same heat of steel. When final heat treatment is in a batch-type furnace, a lot shall include only those tubes of the same size and from the same heat that are heat treated in the same furnace charge. When the final heat treatment is in a continuous furnace, the number of tubes of the same size and from the same heat in a lot shall be determined from the size of the tubjees given in Table 5.

7.2 *Tension and Hardness Tests*—For tension and hardness tests, the term *lot* applies to all tubes prior to cutting, of the ~~hydrostatic test, or, instead~~ same nominal diameter and wall thickness that are produced from the same heat of steel. When ~~final~~ heat ~~treatment~~ is in a ~~nondestructive electric test may be used when specified by~~ batch-type furnace, a lot shall include only those tubes of the ~~p~~ same size and the same heat that are heat treated in the same furnace charge. When the final heat treatment is in a continuous furnace, a lot shall include all tubes of the same size and heat, heat treated in the same furnace at the same temperature, time at heat, and furnace speed.

TABLE 32 Tensile Requirements

| | Grade T1 | Grade T1b | Grade T1a |
|---|-------------------|-------------------|-------------------|
| Tensile strength, min, ksi [MPa] | 55 [380] | 53 [365] | 60 [415] |
| Yield strength, min, ksi [MPa] | 30 [205] | 28 [195] | 32 [220] |
| Elongation in 2 in. or 50 mm, min, % | 30 | 30 | 30 |
| For longitudinal strip tests a deduction shall be made for each $\frac{1}{32}$ -in. [0.8-mm] decrease in wall thickness below $\frac{5}{16}$ in. [8 mm] from the basic minimum elongation of the following percentage | 1.50 ^A | 1.50 ^A | 1.50 ^A |
| When standard round 2-in. or 50-mm gage length or smaller proportionally sized specimen with the gage length equal to 4D (four times the diameter) is used | 22 | 22 | 22 |

^ATable 4 3 gives the computed minimum values.

TABLE 43 Computed Minimum Values

| Wall Thickness | | Elongation in 2 in. or 50 mm, min, % ^A |
|----------------|-----|---|
| in. | mm | |
| 5 / 16 (0.312) | 8 | 30 |
| 9 / 32 (0.281) | 7.2 | 29 |
| 1 / 4 (0.250) | 6.4 | 27 |
| 7 / 32 (0.219) | 5.6 | 26 |
| 3 / 16 (0.188) | 4.8 | 24 |
| 5 / 32 (0.156) | 4 | 22 |
| 1 / 8 (0.125) | 3.2 | 21 |
| 3 / 32 (0.094) | 2.4 | 20 |
| 1 / 16 (0.062) | 1.6 | 18 |

^ACalculated elongation requirements shall be rounded to the nearest whole number.

TABLE 54 Hardness Requirements

| | Brinell Hardness Number (Tubes 0.200 in. [5.1 mm] and over in Wall Thickness), HBW | Rockwell Hardness Number (Tubes less than 0.200 in. [5.1 mm] in Wall Thickness), HRB |
|-----------------------|---|---|
| Grade T 1 | 146 | B80 |
| Grade T 1 | 146 | 80 |
| Grade T 1a | 153 | B84 |
| Grade T 1a | 153 | 81 |
| Grade T 1b | 137 | B77 |
| Grade T 1b | 137 | 77 |

138. Forming Operations

138.1 Tubes when inserted in the boiler shall stand ex-panding and beading without showing cracks or flaws. Superheater tubes when properly manipulated shall stand all forging, welding, and bending operations necessary for application without developing defects.

~~14.~~

9. Product Marking

~~149.1~~ In addition to the marking prescribed in Specification ~~A 450/A 450M~~, A 1016/A 1016M, the marking shall include whether the tube is hot-finished or cold-finished.

150. Keywords

150.1 boiler tubes; carbon-molybdenum; seamless steel tube; steel tube; superheater tubes

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirement shall apply only when specified by the purchaser in the inquiry, contract, or order.

S1. Surface Condition

S1.1 If pickling or shot blasting, or both, are required, this shall be specifically stated in the order. Details of this supplemental requirement shall be agreed upon between the manufacturer and the purchaser.



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SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this specification since the last issue, A 209/A 209M - 98, which may impact the use of this standard. (Approved September 2003)

(I) Revised and re-formatted extensively to adopt the new general requirements specification and conform to the guidelines for form and style. The mandatory hydrostatic test, unless the nondestructive electric test is specified by purchaser per the old Specification A 209/A 209M, was changed to the mandatory nondestructive electric test unless the hydrostatic test is specified by purchaser per Specification A 1016/A 1016M.

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